

which a layer of hard mask material deposited over the intermetal dielectric layer is patterned to less than its full thickness forming a stepped pattern without exposing the underlying intermetal dielectric. The work piece is then etched transferring the stepped pattern into the intermetal dielectric subsequent to which the pattern is filled with a desired metal. The lithography and resist stripping steps of Tobben's two-step hard mask patterning are performed such that the organic (low K) dielectric layer is protected from the oxygen plasma disclosed by Tobben to be the method normally used to do both lithography and resist stripping.

Kikuchi et al. teach a resist-peeling liquid and a method for peeling a resist using the resist-peeling liquid focusing on peeling off the portions of the photoresist which quality of surface layer has changed during the etching operations and various etching conditions. The examples of Kikuchi et al. disclose a glass substrate that has a thin chromium film thereon, onto which a novolak positive photoresist is applied, baked, exposed to light, and developed to form an etch resist pattern. In one example, Kikuchi et al. expose the photoresist to resist-peeling liquid by immersing the substrate into an ultrasonic peeling bath. In column 13, lines 23-25, Kikuchi et al. disclose a plurality of solvents that cannot be used to remove the portion of photoresist which quality has been changed due to less than adequate performance of the solvent. One of such solvents is dimethyl sulfoxide.

Independent claims 20, 26, and 34 recite a method for removing photoresist material from a semiconductor substrate and a method for forming a semiconductor substrate. Among other features, for instance, independent claim 20 recites that the photoresist layer is removed from over the hard mask layer with dimethyl sulfoxide of a high pressure liquid chromatography (HPLC) grade. In a like manner, independent claims 26 and 34 recite implementing dimethyl sulfoxide and liquid of HPLC, respectively. Each independent claim specifically recites that the photoresist is dissolved from over the hard mask layer without substantially damaging the low dielectric constant layer due to the high selectivity of the chemical used.

Citing to Tobben in view of Kikuchi et al., on Page 3 of the Office Action, the Office asserts:

Unlike the claimed invention, neither Tobben nor Kikuchi teach a method wherein a high selectivity of the dimethyl sulfoxide of HPLC grade toward a low dielectric constant material of the low dielectric constant layer causes the dimethyl sulfoxide to chemically dissolve the photoresist layer from over the hard mask layer without substantially damaging the low dielectric constant layer. Kikuchi does teach that the dimethyl sulfoxide chemically dissolves the photoresist layer. Since the dimethyl sulfoxide layer chemically dissolves the photoresist layer and the

same process steps are performed, it is inherent that the dimethyl sulfoxide has a high selectivity toward a low dielectric constant material.

5 It is the Examiner's position that a person having ordinary skill in the art would have found it obvious to modify Tobben by immersing the substrate in an ultrasonic bath of dimethyl sulfoxide for removal of the photoresist layer as taught by Kikuchi therein because Tobben is not particular about the stripping process used for removal of the photoresist layer and therefore the use of a resist peeling process would have been anticipated in order to produce an expected result.

10 These assertions are respectfully traversed, as the combination of Tobben and Kikuchi et al. does not raise the prima facie case of obviousness against independent claims 20, 26, and 34. To establish a prima facie case of obviousness, it is well established that there must be some suggestion or motivation in the cited prior art to modify Tobben in the manner proposed by the Examiner. Furthermore, in the absence of
15 some objective reason to modify Tobben to obtain the claimed invention, that the proposed modification may be within the capabilities of one of ordinary skill in the art is irrelevant to the issue of obviousness.

It is respectfully submitted that, here, the Office has not pointed out to any objective reasoning that would have motivated one skilled in the art to ignore the definite
20 teachings of Tobben and replace the plasma oxide etching that is the prevalent method of removing photoresist layers by immersing the substrate in an ultrasonic bath of dimethyl sulfoxide of Kikuchi et al. In the absence of such objective reasoning, Tobben does not support the Office's assertions.

It is further submitted that in contrast to the Office's contention, Tobben
25 particularly discloses removal of photoresist using plasma oxide etching. On at least two occasions, Tobben addresses use of oxide plasma etching as the predominant and widely used method for removing photoresist material. For instance, in column 1, lines 32-35, Tobben discloses that "[t]his poses problems since the use of oxygen plasmas is the method of choice for stripping the residual photoresist and anti-reflection coatings (ARC)
30 that are in wide use in the photolithography used for patterning the various layers involved." Also in column 3, lines 57-62, Tobben says "[m]oreover, this stepped pattern has been formed in the hard mask 16 in a way that both lithography and the resist stripping steps are performed while the organic IMD layer 14 is completely protected from the oxygen plasma that normally will be used to do both the lithography and resist
35 stripping for forming the stepped pattern in the hard mask." Thus, a skilled artisan reading the teachings of Tobben would not have been motivated ignore the oxide plasma etching (i.e., the method of choice) taught by Tobben to arrive at the methods of claimed invention in which the photoresist material is dissolved using a dissolving liquid.

It is further submitted that Tobben does not disclose or suggest solving of the photoresist material nor does it disclose using of dimethyl sulfoxide to dissolve the photoresist. Thus, again, one having ordinary skill in the art reading Tobben would not have been motivated to disregard the predominant method of choice of oxide plasma etching by the claimed invention.

The Applicant further traverses Office's assertion that it is inherent that the dimethyl sulfoxide has a high selectivity toward a low dielectric constant material because the Office's conclusion is based on unfounded premises attributed to Kikuchi et al. First, in contrast to the Office's assertion, Kikuchi et al. do not disclose, suggest, or teach removing of photoresist material from over the low dielectric constant material. In fact, Kikuchi et al. is silent as to implementing the resist-peeling liquid of Kikuchi et al. to remove photoresist material in substrates implementing low dielectric constant dielectric as well as the problems associated with removal of photoresist material where low-K dielectric materials are implemented.

Second, contrary to the Office's assertion, Kikuchi et al. do not disclose, suggest, or teach implementing dimethyl sulfoxide to remove photoresist from over the low dielectric constant material. Third, Kikuchi et al. do not disclose, suggest, or teach that dimethyl sulfoxide has a high selectivity toward low dielectric constant materials. Thus, it is respectfully submitted that in reaching its conclusion, the Office has made certain assumptions none of which are disclosed, suggested, or taught by Kikuchi et al.

In fact, it is respectfully submitted that Kikuchi et al. teach away from implementing the dimethyl sulfoxide to remove the photoresist material. In column 3, lines 43-49, Kikuchi et al. disclose:

The resist-peeling liquid of the present invention is suitable particularly for peeling a layer formed by the change in quality of the surface of a resist, which change in quality is caused by a strongly oxidative wet etching solution of metallic chromium, dry etching of silicon or aluminum, dry etching using oxygen plasma, or ion implantation.

Kikuchi et al. then proceed to disclose that dimethyl sulfoxide is not capable of removing portions of the photoresist which characteristics has been changed. Accordingly, one reading Kikuchi et al. would not have been motivated to use Kikuchi et al.'s method or resist-removing liquid to remove the photoresist material characteristics of certain portion of which has been changed by the oxide plasma etching disclosed by Tobben.

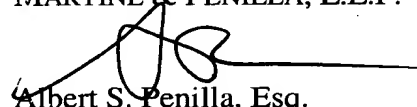
Thus, the Applicants further submit that the Office cannot implement the claimed invention as an instruction manual to piece together the dual damascene semiconductor of Tobben implementing low-K dielectric and the disclosure of using of dimethyl sulfoxide

to remove photoresist material of Kikuchi reference to arrive at the claimed invention as defined in independent claims 20, 26, and 34. (See In re Fritch, 23 U.S.P.Q.2d 1780, 1784 (Fed. Cir. 1992) wherein the Court of Appeals for the Federal Circuit held that "... it is impermissible to use the claimed invention as an instruction manual or "template" to piece together the teachings of the prior art so that the claimed invention is rendered obvious. This court has previously stated that "[o]ne cannot use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention."").

Accordingly, it is respectfully submitted that independent claims 20, 26, and 34 are patentable over the cited art of record, individually and collectively. Likewise, dependent claims 21-25, 27-33, and 35-37 are also submitted to be patentable over the cited art of record for at least the same reasons discussed above. Accordingly, the Applicant respectfully requests that the § 103(a) rejections be withdrawn.

In view of the foregoing, the Applicant respectfully submits that all pending claims (20-38) are in condition for allowance. Accordingly, a Notice of Allowance is respectfully requested. If the Examiner has any questions concerning the Response to Office Action, the Examiner is kindly requested to contact the undersigned at (408) 749-6903. If any additional fees are due in connection with filing this Proposed Amendment, the Commissioner is also authorized to charge Deposit Account No. 50-0805 (Order No. LAM2P266). A duplicate copy of the transmittal is enclosed for this purpose.

Respectfully submitted,
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